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FORECAST OF 1968 PINK SALMON RUNS, SOUTHEASTERN ALASKA

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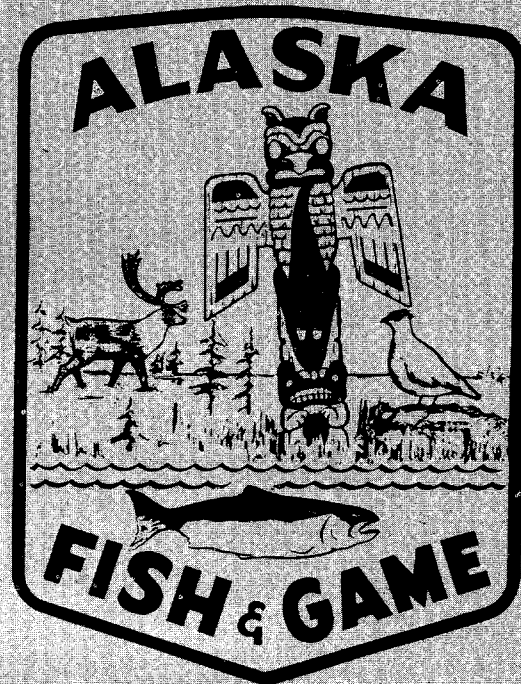
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INTRODUCTION

In the spring of 1967 (February through March) the fourth series of pre-emergent pink salmon fry samples were taken from the spawning streams of Southeastern Alaska. Previous sampling had been done in 1964, 1965, and 1966, with some pilot work performed in 1963.

The work done prior to 1966 should be considered as preliminary data gathering only. No attempt at predicting runs of pink salmon can reasonably be made until sufficient information is at hand. For example, the 1964 and 1965 pre-emergent fry samples were used for predicting the 1965 and 1966 pink salmon runs to Southeastern Alaska without knowing what these fry values meant in terms of returning adults (Hoffman 1965, 1966). That these forecasts lacked accuracy surprised no one, least of all those requested to make them. Until the resulting return run of adults has occurred, a pre-emergent fry value has no meaning, and a forecast made without this segment of information should be treated with more than ordinary caution.

Pink salmon live only two years from fertilization of eggs to death shortly after their one and only spawning. The even-year and odd-year populations therefore remain genetically distinct and frequently exhibit different behavior patterns. For this reason, even-year and odd-year pink salmon data must often be considered separately and information for the two cycles may not be combined. This is true of forecasting pink salmon runs in Southeastern Alaska.

The 1967 forecast was the first made in this region for which information was at hand covering a prior two year life cycle (Smedley and Seibel, 1967). Our sampling in 1964 had resulted in a fry value for eggs deposited in 1963, and the adult return in 1965 provided us with a means of estimating what the 1964 fry value meant. For the first time we were in possession of data covering a complete previous odd-year cycle (1963-1965) and were in a position to estimate what the odd-year pre-emergent fry index found in 1966 might mean in terms of returning adults in 1967.

We are now in the same position for the even-year cycle that will end with the pink salmon run of 1968. Sampling in 1965 of eggs deposited in 1964 and the known return of adults in 1966, has provided us with prior cycle (1964-1966) information. This absolute minimum of background data permits us to attempt forecasting the 1968 pink salmon runs to the northern and southern halves of Southeastern Alaska (Figure 1) from the pre-emergent fry sampling done in the spring of 1967.

It should be clearly understood that no one considers one cycle, whether even-year or odd-year, a sufficient base upon which to build a forecast. These early predictions should be only provisionally accepted until additional background data is at hand.

METHODS

Basic pre-emergent fry sampling methods and gear have been described previously (Noerenberg, 1961) but should probably be outlined again since some changes have occurred. Choosing the streams to be sampled for example is sometimes an involved process. Southeastern Alaska contains many major pink salmon spawning streams that average annual runs in excess of 10,000 fish. Some of these cannot be sampled because of their large size, others because of their glacial turbidity. There are many other salmon streams that are too small to be included as major producers but that in the aggregate, produce important numbers of pink salmon and must therefore be considered in forecasting.

In 1963 a total of 85 streams (not all major producers) was examined for sampling suitability and 60 of these were randomly chosen for sampling in 1965. Of these, 46 were actually sampled by Department of Fish and Game workers. A year later a new group was chosen from a somewhat revised list of suitable streams and 45 were sampled by Department personnel. In 1966 the stream list was considerably revised and 63 streams were sampled. Through-
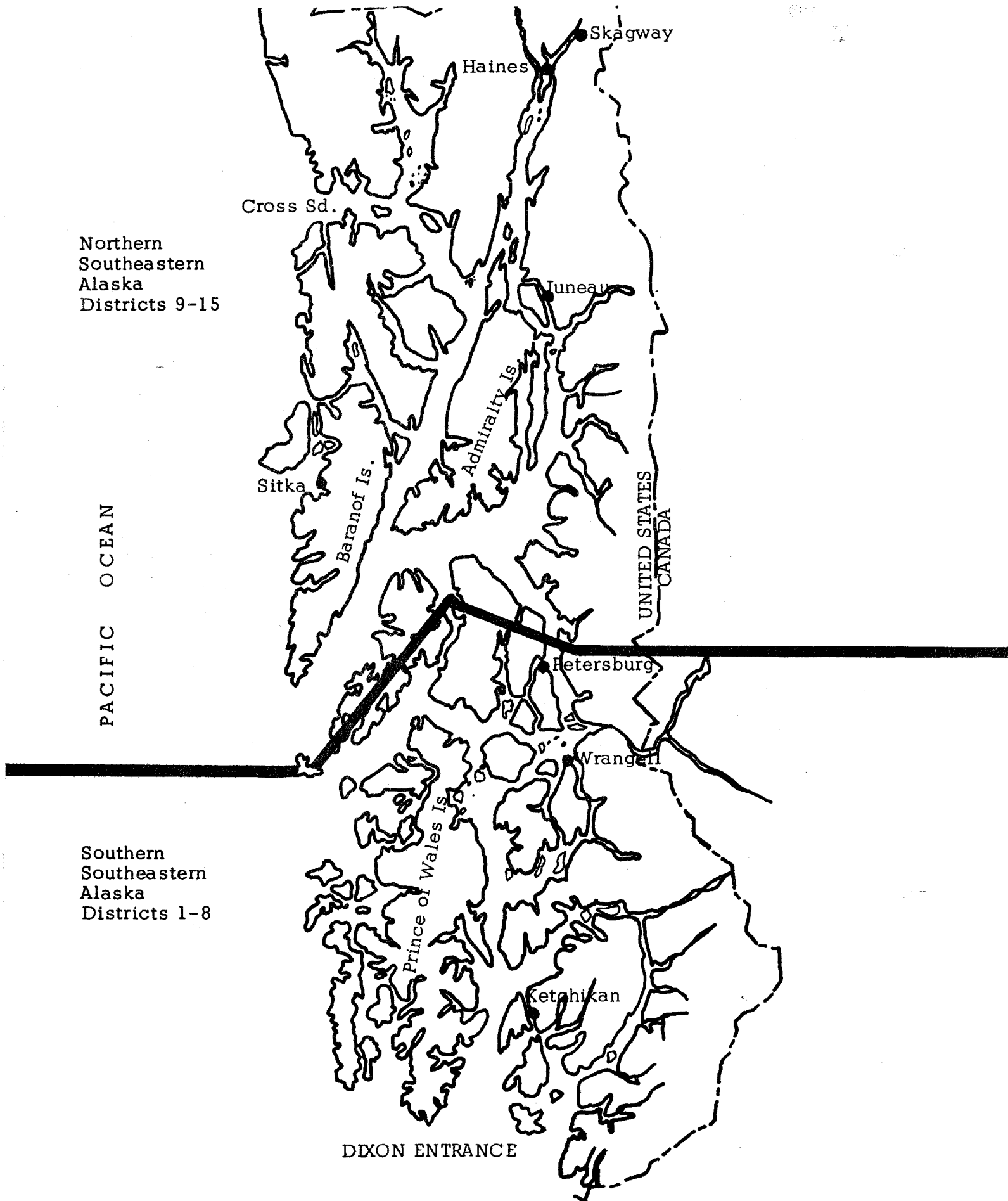
Figure 1. Map of Southeast Alaska showing division between northern and Southern sections.

out this period, the random method of choosing streams had been steadily losing ground through interest in selective sampling and in 1967 nearly half of the 79 streams sampled were specifically chosen rather than randomly selected.

From 1964 through 1967 the areas sampled in the chosen streams were units drawn from sections previously surveyed and known to be used by spawning salmon. These sections were measured and divided into basic sampling units containing one acre (43,560 sq. ft.) or, in the case of smaller streams, tenths of an acre. Large streams frequently contained more than one unit (acre) of spawning area for possible sampling with each unit marked for field identification. Each unit or fraction of a unit was assigned an identifying number printed on a small cardboard disc and deposited in a container. These discs, randomly drawn from the container identified the unit, its location, the stream to which it belonged, and hence automatically determined which streams were to be sampled.

The sampling effort expended amounted to 40 two-square foot sample digs per unit (acre) generally placed in a "cluster" of 5 digs evenly spread across the width of the stream bed at right angles to water flow. Lengthwise spacing of the clusters was sometimes established by a table of random numbers and sometimes by arbitrarily selecting a starting point and from this point onward equally spacing the clusters throughout the remaining length of the sample area. Variation from this ideal pattern is sometimes forced upon workers in the field by the presence of ice, high or low water, or other environmental difficulties. Under such conditions experienced crew leaders compensate as best they can, attempting to maintain the rate of sampling at 1 sample dig per 1,000 square feet or 40 digs per acre.

In the field, basic units of gear consist of a Homelite Model XLS 1-1/2-1 gasoline driven centrifugal pump equipped with hoses and probe, a combined sampling frame and collecting net, and various smaller items such as pans, tools, gasoline, notebooks, etc. Methods of reaching streams in Southeastern Alaska include state vessels, skiffs, small fixed-wing float planes (usually Cessna 185), and in upstream areas the Bell 112 helicopter. In most areas the normal three man crew and approximately 150 pounds of gear are landed on the beach by fixed-wing aircraft. In the more remote upstream sampling sections where access is by helicopter the sampling crew is reduced to two men.

The 21 pound pump has a capacity of 4,200 gph and is mounted in operating position on a plywood packboard. A 12-foot intake hose supplies the pump with water which is fed through a 3-foot discharge hose into the aluminum tubing probe by which actual gravel digging is accomplished. Both hoses are 1-1/2 inch in diameter.

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Built into the probe is a Venturi assembly which introduces air into the discharging water column and thence into the gravel of the spawning bed. The air-water mixture thus injected forces salmon eggs, pre-emergent fry and other materials upward through the gravel and into the current of the stream which carries these items down and into a collecting net attached to the sampling frame.

The circular sampling frame is calculated to enclose 0.2 square meter of area and is 20 inches high. The upstream half is covered with hardware cloth permitting nearly free passage of the stream current, while the downstream half of the frame opens into a fine mesh nylon collecting net some six feet in length.

In practice the frame is set firmly on the surface of the gravel bed at the chosen sampling point while the collecting net extends downstream and is held in position by the current. The probe, injecting its mixture of air and water, is worked about within the area of the sampling frame, and to depths of about 12 inches, for about 1 to 3 minutes depending on the substrate. The 6 foot collecting net permits some automatic separating of collected materials. Heavy mineral fragments (sand and gravel) tend to settle out upstream, while the lighter organic items usually are found at the distal end of the net. This is an open end kept closed by a large binder-type clip until the sample is shaken into aluminum pans for examination.

Eggs and alevins are identified (pinks or chums usually), counted, the number of dead and live noted, and remarks of interest also noted. These may concern stage of development, presence of predators or of quantities of shells or egg fragments, indications of gravel shift, or ice scour, etc. Data is recorded on prepared Mylar forms and the crew moves on to the next sampling point.

Prior Forecasts, 1965, 1966, 1967

Evaluation of the forecasts for 1965 and 1966 was done by Smedley and Seibel (loc. cit.) where it was pointed out that since no background data existed for either of those original odd-year or even-year cycles little accurate information could be expected from either forecast.

Almost the same statement can be made for the 1967 forecast but we did have one complete odd-year cycle behind us, the sampling done in 1964 and the returning pink salmon run of 1965. The pre-emergent sampling effort

in 1964 was small and was not considered representative, but for all its limitations it was information of some significance not previously on hand. Because of this limited pre-emergent data, the 1967 forecast was partially based (one-third weight) on the escapement-return relationships found in the period 1960-1966.

The escapement-return relationship is based on estimated escapement plotted against the total run produced by it two years later. The "escapement" segment of this relationship is obtained by area management biologists who estimate spawner escapement into all streams of their respective districts. The resulting figure does not represent total escapement but is considered an escapement index. The "return" segment is the total run occurring two years later and includes both catch and the estimated escapement at that time. Since escapement figures are only rough estimates, the use of the escapement-return relationship will be discontinued as soon as sufficient pre-emergent fry sampling data becomes available.

Table 1 shows the 1967 forecast as originally made for northern and southern Southeastern and also includes the total return to both areas. If, in southern Southeastern, the escapement-return and the adjusted fry index are ignored, the pre-emergent index of 2.3 is close to what actually occurred. Similarly, in northern Southeastern (again ignoring the escapement-return), the pre-emergent index figure of 2.5 is not too far off if one remembers the statement in the original report that the prediction of 2.5 million pink salmon was to be considered a minimum return. Further, if one ignores the actual figures of the 1967 forecast and looks upon it as simply a prediction of a poor pink salmon run, the forecast must be considered as correct. In spite of these charitable approaches, substantial errors occurred in the 1967 forecast, most of them traceable to the lack of pre-emergent fry data. We are in the same position in making the 1968 prediction.

Table 1. Southeastern Alaska 1967 Pink Salmon Forecast and Actual Return (in millions).

Forecast Basis	Southern Half		Northern Half		Total	
	Forecast	Return	Forecast	Return	Forecast	Return
Escapement-Return	8.1	2.2	9.7	4.6	17.8	6.8
Pre-emergent Index	2.3-4.0*	2.2	2.5	4.6	4.8-6.5	6.8
Weighted Forecast	4.2-5.4	2.2	4.9	4.6	9.1-10.3	6.8

* Adjusted fry index based on sampling prior to April 1.

1968 Data Analysis

As in 1967, the limited nature and amount of data available for predicting 1968 returns to Southeastern Alaska prohibits statistical analysis. Confidence intervals, calculated spawner-recruit curves, correlation coefficients and similar manipulations require information not yet extant. At this writing pre-emergent sampling has been conducted in 1964, 1965, 1966 and 1967. But odd-year and even-year data must be handled separately and only the pre-emergent fry sampling of 1965 and the adult return of 1966 exist as even-year cycle information usable in forecasting the 1968 even-year pink salmon run.

For this reason we will again include the annual escapement index counts and the annual pink salmon catch as supporting information. Both these items are shown individually in Table 2 and are then summed to show estimated total run. The item labeled "Escapement Index" in Table 2 is a calculated index derived from the sum of the peak spawner counts in surveyed streams and applied to unsurveyed streams of similar characteristics. It does not represent actual escapement.

In the 1967 forecast the escapement-return relationship was arbitrarily assigned a value of one-third in deriving the Weighted Forecast (Table 1). For 1968, the Escapement-Return relationship will be assigned a weight of one-fourth since the one-third value used in 1967 proved too high. There will be no change in our 1967 method of considering Southeastern Alaska as two separate biological entities; the southern half, and the northern half (Figure 1).

Escapement-Return Estimate

The use of escapement-return data in forecasting pink salmon runs to Southeastern Alaska is justified by our lack of pre-emergent background. It is recognized that escapement-return data is far from exact, but such information is not without some value and, in these early forecasts, must carry some weight.

From Table 2 it can be seen that in southern Southeastern the average run for the even-numbered years has been 13.9 million pink salmon and has ranged from 3.5 to 21.0 million. Even-year escapements have averaged 4.1 million and have ranged from 1.5 to 5.4, with the last and highest figure representing the parents of the 1968 run we are attempting to predict. Further, the even-year cycle is the dominant cycle in southern Southeastern.

In northern Southeastern the escapement-return data appears less favorable. The average even-year run (Table 2) is only 5.5 million and has ranged

Table 2. Southeastern Alaska Pink Salmon Runs 1960-1967 (thousands of fish)

SOUTHERN SOUTHEASTERN

Year	1960	1961	1962	1963	1964	1965	1966	1967	Average Odd Years	Even Years
Escapement Index	1,927	2,355	4,235	3,915	4,745	2,944	5,402	1,507	2,680	4,077
Catch	1,540	3,875	11,007	5,146	11,259	5,709	15,622	658	3,847	9,857
Total Run	3,467	6,230	15,242	9,061	16,004	8,653	21,024	2,165	6,527	13,934

NORTHERN SOUTHEASTERN

	1960	1961	1962	1963	1964	1965	1966	1967	Odd Years	Even Years
Escapement Index	1,241	2,562	1,924	4,027	2,111	2,517	2,787	2,228	2,834	2,016
Catch	1,429	8,698	560	13,920	7,246	5,098	4,752	2,387	7,528	3,497
Total Run	2,670	11,260	2,484	17,947	9,357	7,615	7,539	4,615	10,359	5,512

from 2.4 to 9.3. The odd-year runs have averaged nearly double (10.4 million) those of the even-years, but in 1964 something occurred that upset this odd-year dominance in northern Southeastern. The even-year average escapement of 2.0 million was exceeded in 1966 by the 2.8 million parent escapement that will produce the 1968 run.

Escapements, and the returns produced by them, are plotted in Figure 2 for southern Southeastern and Figure 3 for the northern area. Based on escapement-return data only, Figure 2 indicates a return of 25.2 million pink salmon in 1968 to the southern section and Figure 3 forecasts a return of 9.1 to the northern section. It will be noted that in Figure 2 the odd-year and even-year data are handled separately. This approach was not warranted in Figure 3 since the dominant cycle is now in doubt in northern Southeastern.

Pre-emergent Values

The use of the above escapement-return data in estimating the 1968 pink salmon runs was accompanied with full awareness that this approach smooths the peaks and valleys of the abundance range. Our limited pre-emergent fry values may, however, replace some of these points.

Table 3 shows the sampling effort expended in Southeastern Alaska since the inception of the program in 1964. In that year, and in 1965, sampling effort was low and in 1966 the number of streams sampled was raised to 63, a 28.6 percent increase. Seeking a still better sample, the number of streams sampled in 1967 was raised to 79, a 21.6 percent further increase. As Table 3 indicates the average number of samples per stream has been maintained at about the same level.

Table 3. Pink salmon pre-emergent sampling Southeastern Alaska, 1964, 1965, 1966, 1967.

Year	No. of Streams Sampled By ADF&G	By Others	Points Dug by all Agencies Downstream	Upstream	Total	Average Points/Stream
1964	46	5*	2,141	546	2,686	58.4
1965	45	5*	1,940	729	2,669	57.1
1966	63	0	2,340	1,026	3,366	53.4
1967	79	1**	3,032	1,598	4,630	58.6

 * Harris R., Twelvemile Cr., by FRI: Lovers Cove, Sashin Cr., Traitors Cove, by BCF.
** Sashin Creek by BCF.
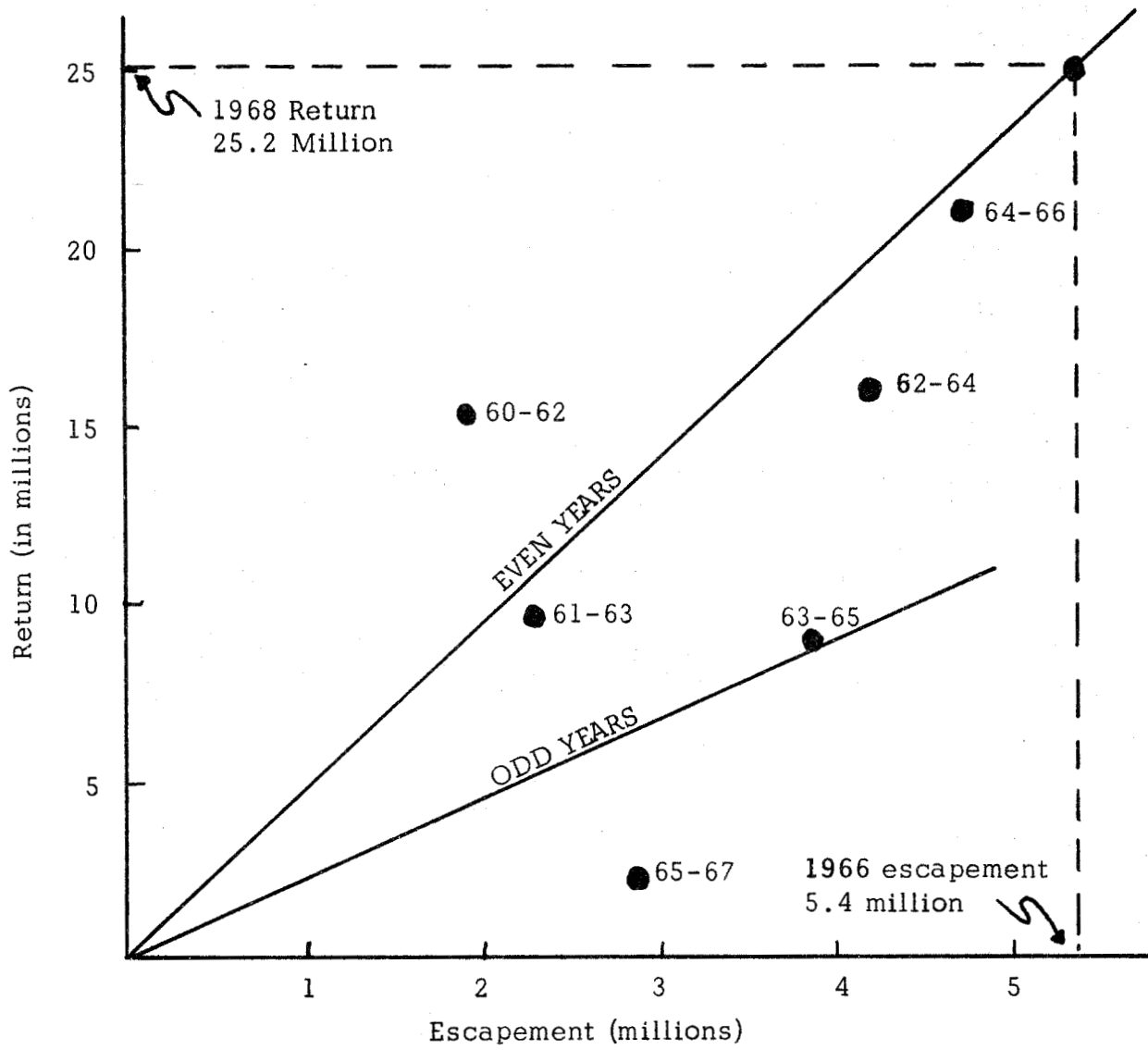
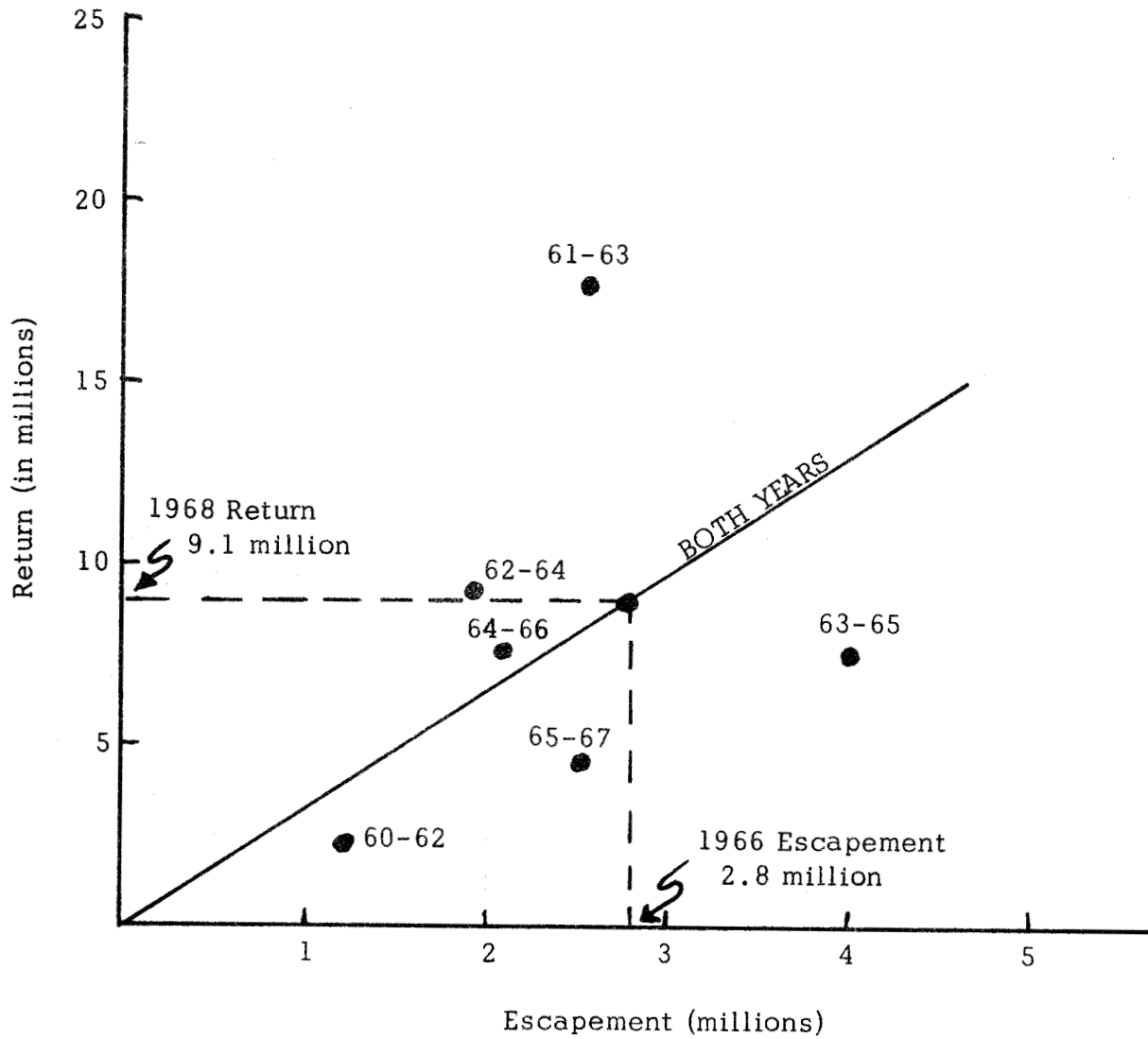Figure 2. Southeastern Alaska pink salmon escapement/return relationship.

Figure 3. Southeastern Alaska pink salmon escapement/return relationship.

Table 4 shows the figures involved in forecasting pink salmon runs to southern and northern Southeastern Alaska. Reading across the table the values represent the escapement index for a given year, the pre-emergent fry index found the following spring, the adult return appearing the next year and the predicted return based on the fry index and the escapement-return relationship. From Table 4 it is evident that 1964-1966 is the only data available covering a prior even-year cycle.

Table 4. Escapement, pre-emergent, return run, and prediction data; Southeastern Alaska

SOUTHERN SOUTHEASTERN

Escapement (in millions)	Fry Indices (per sq. 0.1 m)	Return Run (in millions)	Prediction (in millions)
3.9 (1963)	19.6 (1964)	8.7 (1965)	*
4.7 (1964)	16.0 (1965)	21.0 (1966)	10.0**
2.9 (1965)	5.0 (1966)	2.2 (1967)	4.2 - 5.4
5.4 (1966)	15.5 (1967)	? (1968)	21.5

NORTHERN SOUTHEASTERN

Escapement (in millions)	Fry Indices (per sq. 0.1 m)	Return Run (in millions)	Prediction (in millions)
4.0 (1963)	19.2 (1964)	7.6 (1965)	*
2.1 (1964)	20.6 (1965)	7.5 (1966)	10.0**
2.5 (1965)	8.6 (1966)	4.6 (1967)	4.9
2.8 (1966)	12.4 (1967)	? (1968)	6.2

 * First year; no prediction
** Ten million predicted for all Southeastern

Pre-emergent Forecast for Southern Southeastern

To estimate pink salmon returns from pre-emergent fry sampling requires that sampling values be related to the adult return produced by the sampled fry. Figure 4 shows graphically the available data for southern Southeastern and since we are attempting to forecast an even-year return, the 1964-1966 cycle is of pri-
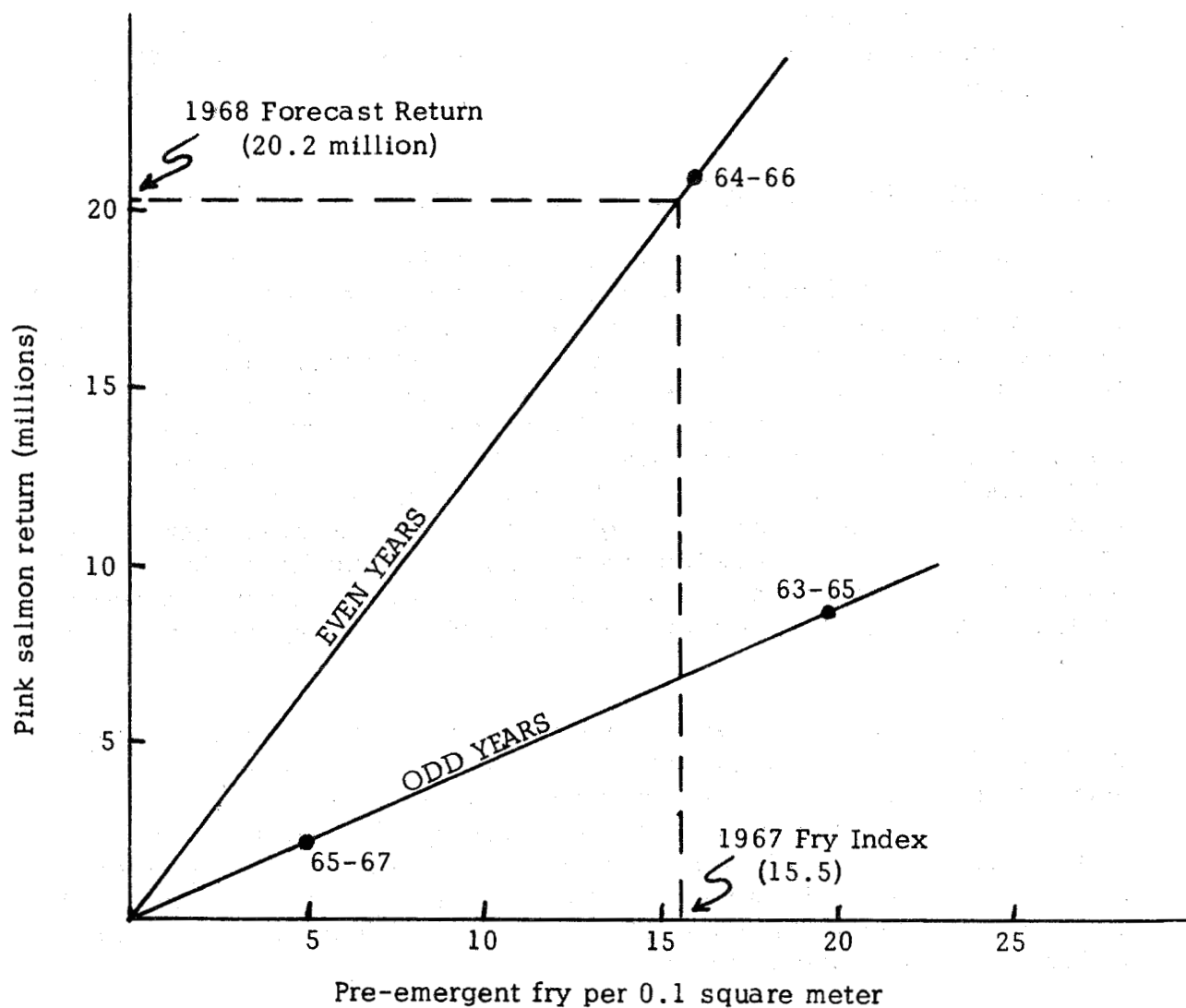
SOUTHERN SOUTHEASTERN

Figure 4. Southeastern Alaska pink salmon pre-emergent fry/adult return
relationship.

mary interest.

Linear regression equations have not been calculated for our scanty data, but trend lines have been drawn. From these it is apparent our forecast for southern Southeastern, if based on pre-emergent fry data alone, would be in the neighborhood of 20.2 million pink salmon in 1968. As with the escapement-return data (Figure 2), the dominance of the even-year pinks in southern Southeastern requires separate trend lines for the odd- and even-year cycles.

1968 Pre-emergent Forecast for Northern Southeastern

In the northern section the odd-year cycle was dominant in 1961 and 1963 but in 1965 odd-year dominance failed to materialize in spite of excellent escapement in 1963, the parent year. Reasons for this collapse of dominance are still being sought. It has been suggested that effects of heavy egg deposition (in 1963) may somehow effect the environment and suppress freshwater survival of eggs and embryos the following year, and that such effects, if lasting through the second year (in pink salmon), may suppress the dominant cycle itself (Hunter, 1959). Table 2, however, shows that in 1964 (the following year) escapement was slightly better than the even-year average, and that survival of the resulting eggs in this theoretically critical year was good enough to produce in 1966 a total run also higher than the even-year average. Pre-emergent fry values in 1965 (1964 spawning) were also high (Table 4).

There was some question whether odd-year dominance would reassert itself in 1967 but such an event was held unlikely on the basis of the poor showing of pre-emergent fry found in 1966. Table 2 demonstrates this to have been correct, and since no dominant cycle can currently be shown in northern Southeastern we are limited to a single trend line for pre-emergent fry data in Figure 5. From Figure 5 it will be seen that a forecast for northern Southeastern based on pre-emergent fry data alone would be in the magnitude of 5.2 million pink salmon in 1968.

Summary of Forecasts

As in 1967, the 1968 pink salmon forecast will be based on both the escapement-return relationships and on the pre-emergent fry indices. Weighting,
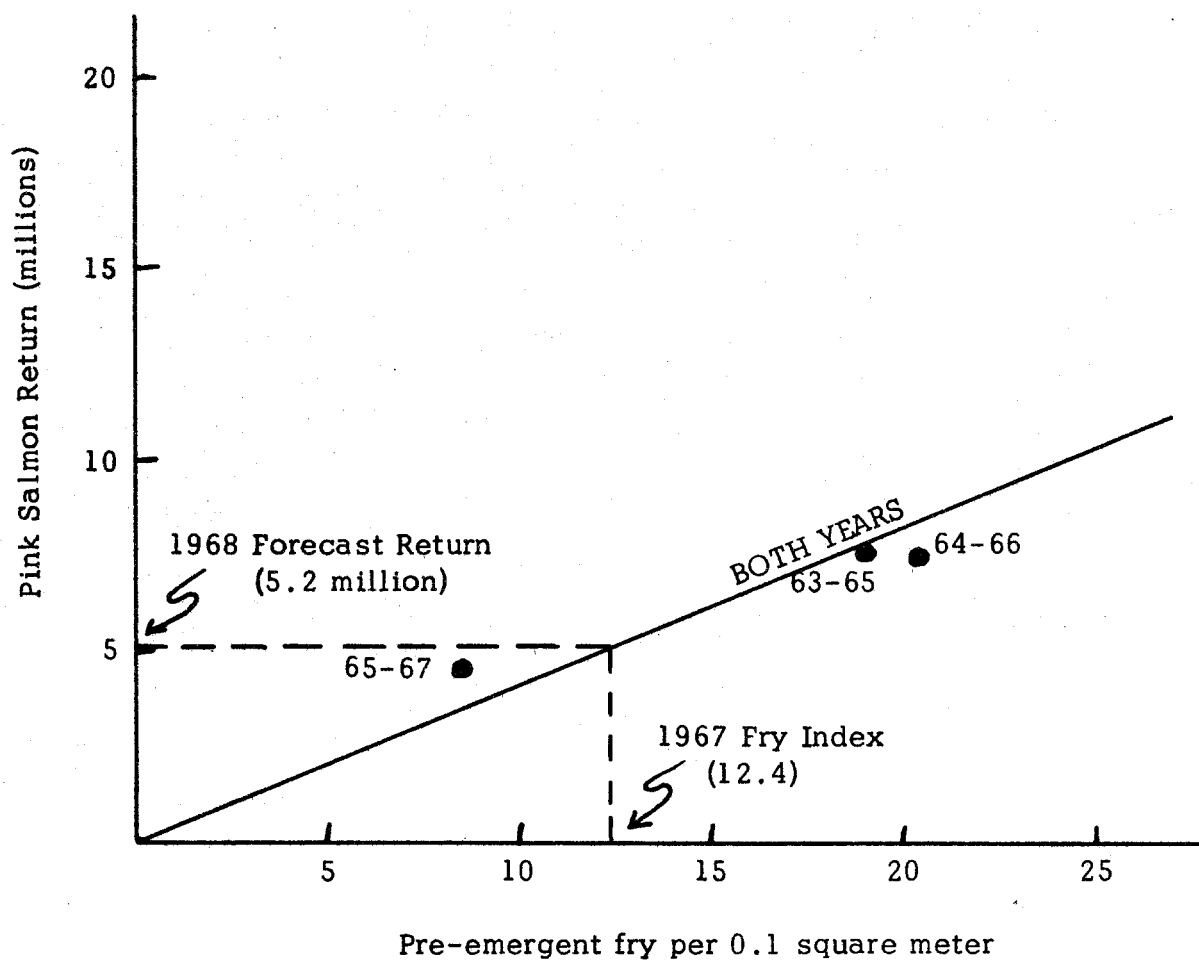
Figure 5. Southeastern Alaska pink salmon pre-emergent fry/adult return
relationship.

however, will differ. The 1967 forecast was arbitrarily weighted in favor of the pre-emergent fry values by a ratio of 2:1. In 1968 we will favor these values in the ratio of 3:1 since the 1967 ratio resulted in figures higher than the actual returns (Table 4). Although our pre-emergent data is limited in quantity it provides information at a much later life stage than does escapement. It follows that pre-emergent values, being derived after significant natural mortalities have occurred, should provide a closer estimate of returns than the earlier escapement data.

Table 5 shows three different types of forecast. One based on the escapement-return data only, and a second based on the pre-emergent fry values only. The third is the weighted forecast that constitutes our best estimate of the numbers of pink salmon destined to return to the southern and northern sections of Southeastern Alaska in 1968.

Table 5. Southeastern Alaska Pink Salmon Forecast, 1968 (millions).

Type of Forecast	Southern Southeastern	Northern Southeastern	Total Southeastern
Escapement-Return	25.2	9.1	34.3
Pre-emergent Index	20.2	5.2	25.4
Weighted Forecast	21.5	6.2	27.7

No forecast based on the limited data currently on hand should be accepted without reservation. Table 5 indicates a pink salmon run of 21.5 million fish in 1968 to the southern half of the region and 6.2 million pink salmon to the northern section. This estimate, however, is based on only one previous even-year cycle in addition to the highly variable escapement-return data collected since 1960. Discretion demands data for at least 3-4 cycles for both even- and odd-years before Southeastern Alaska forecasts can be considered as tested predictions.

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